In the 21st Century

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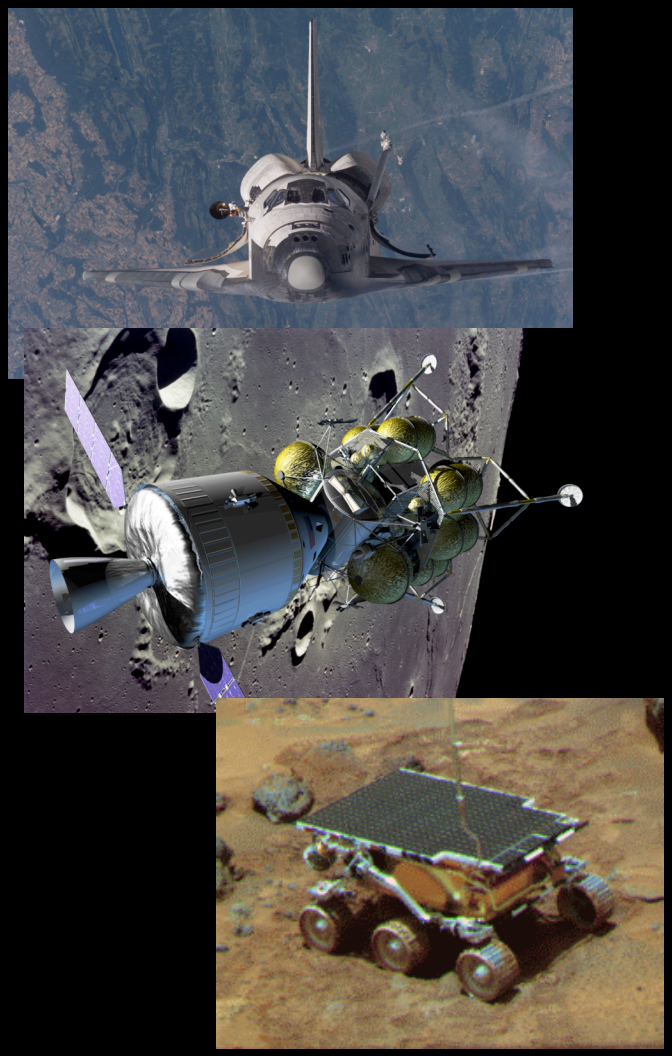
National Aeronautics and Space Administration

Vision for Space Exploration

- Announced by President Bush on January 14, 2004
- Sustained human and robotic exploration of the solar system
  - Complete the International Space Station
  - Safely fly the Space Shuttle until 2010
  - Develop and fly the Crew Exploration Vehicle no later than 2014 (goal of 2012)
  - Return to the Moon no later than 2020
  - Extend human presence across the solar system and beyond
  - Implement a sustained and affordable human and robotic program
  - Develop supporting innovative technologies, knowledge, and infrastructures
  - Promote international and commercial participation in exploration



NASA Mission Directorates

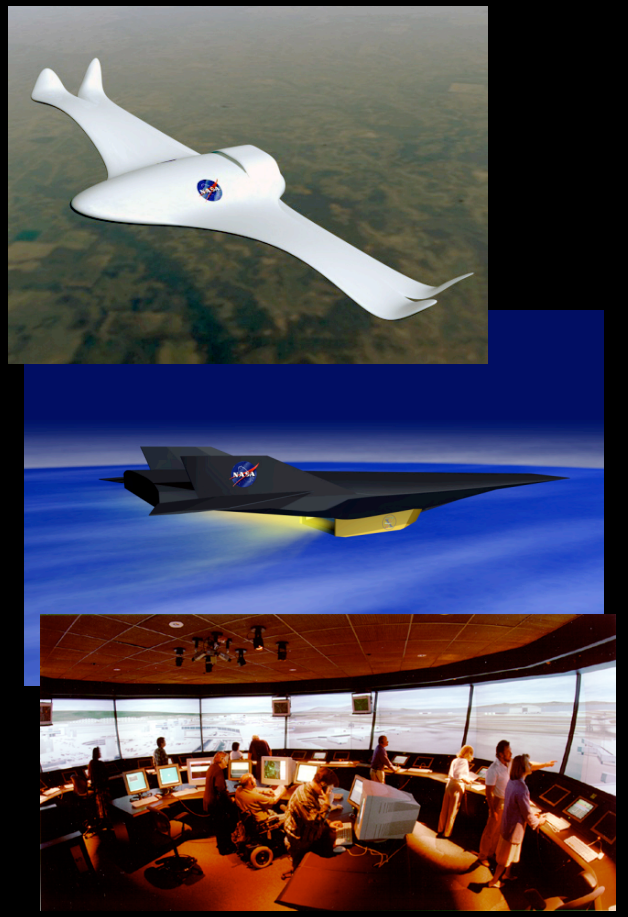
- Program divided into 4 missions:
  - Aeronautics
    - Enable a safer, more secure, efficient, and environmentally friendly air transportation system.
  - Science
    - Exploring the Earth-Sun system, our own solar system, and the universe beyond.
  - Space Operations
    - Extend the duration and boundaries of human space flight to create new opportunities for exploration and discovery.
  - Exploration Systems
    - Direct the identification, development, and validation of exploration systems and technologies.

NASA Centers

- Ames Research Center
  - Mountain View, CA
  - Aerospace technologies
- Dryden Flight Research Center
  - Edwards, CA
  - Flight research and test
- Glenn Research Center
  - Cleveland, OH
  - Aeropropulsion and communication technologies
- Goddard Space Flight Center
  - Greenbelt, MD
  - Earth, solar system, and universe observations
- Jet Propulsion Laboratory
  - Pasadena, CA
  - Robotic space exploration
- Johnson Space Center
  - Houston, TX
  - Human space exploration
- Kennedy Space Center
  - East coast of Florida
  - Space launch prep & execution
- Langley Research Center
  - Hampton, VA
  - Aeronautics and space research
- Marshall Space Flight Center
  - Huntsville, AL
  - Space transportation and propulsion technologies
- Stennis Space Center
  - Southern Mississippi
  - Rocket propulsion testing and remote sensing tehcnologies

Aeronautics Mission

- Currently in a replanning effort
- Three Principals:
  - We will dedicate ourselves to the mastery and intellectual stewardship of the core competencies of Aeronautics for the Nation in all flight regimes.
  - We will focus our research in areas that are appropriate to NASA's unique capabilities.
  - We will directly address the R&D needs of the Next Generation Air Transportation System (NGATS) in partnership with the member agencies of the Joint Planning and Development Office (JPDO).



Imagining the Future of Air Travel

- Imagine a world where:
  - Airliners don't burn fossil fuels
  - Aircraft could stay aloft for days, weeks, or months at a time to:
    - Monitor the environment
    - Enhance our security
    - Help us communicate
  - Flight delays caused by air traffic congestion are virtually unheard of
  - You can fly coast-to-coast in under 2 hours – without a sonic boom disturbing people on the ground
  - You can fly people or cargo between ***any*** two major cities in the world in under 2 hours

Aeronautics Programs

- Three major Aeronautics technology programs
  - Fundamental Aeronautics
    - Subsonic Fixed and Rotary Wing projects
    - Supersonics project
    - Hypersonics project
  - Aviation Safety
    - Integrated Vehicle Health Management project
    - Integrated Intelligent Flight Deck project
    - Integrated Resilient Aircraft Control project
    - Aircraft Aging and Durability project
  - Airspace Systems
    - Airspace project
    - Airportal project
- Focused on making what we can imagine today the reality of tomorrow

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The Future is Closer Than You Think!

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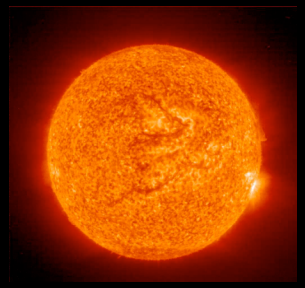
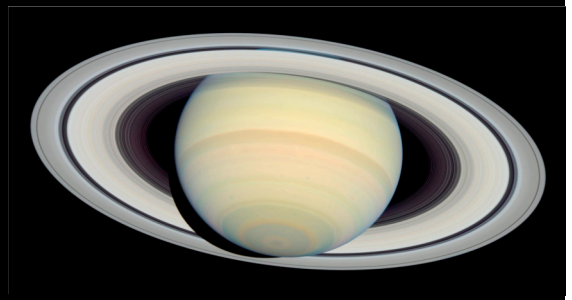
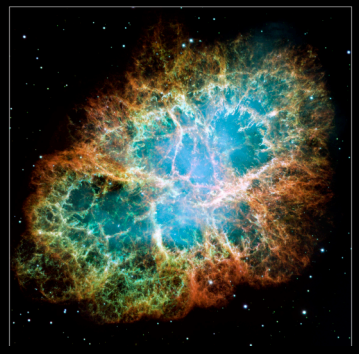
Science Mission

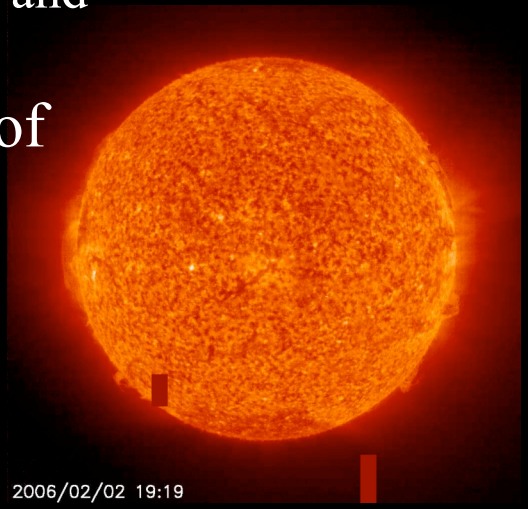
- Responsible for broad range of NASA scientific research
- 3 mission areas
  - Earth-Sun System
  - Solar System
  - Universe




Earth-Sun System Science

- Utilizes ground based, airborne, and space based instruments to study
  - Factors influencing climate change
    - Impact of the Sun on Earth
    - Human impacts
  - Utilize data to understand and predict weather and the environment here on Earth
- Responsible for development and launch of U.S. weather satelites
  - POES
  - GOES



Solar System Science

- Current activity
  - Mercury (MESSENGER, 2011)
  - Mars (5 missions)
  - Saturn (Cassini)
  - Pluto (New Horizons, 2015)
  - Comets (Deep Impact, 2004; Rosetta, 2014)
  - Edge of the Solar System (Voyager)
- Future missions
  - 3 Mars missions
  - 1 robotic Lunar mission
  - 1 mission to asteroids Vesta and Ceres

Universe Science

- Exploring the depths of the universe through earth based and space based assets
  - 15 active missions
    - 14 are space based
  - 14 missions in work
    - 12 are space based
- Over 100 planets discovered
  - At least 1 planet with an atmosphere
- Most famous project: Hubble Space Telescope

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15 Years of Hubble

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Space Operations

- Space Shuttle
- Space Station
- Launch Services
  - Expendable vehicles
- Space Communications
  - TDRS
  - Ground based

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Space Shuttle

- First flight in April, 1981
- Scheduled for retirement in about 2010
- Primary mission today is Space Station assembly and re-supply
  - May perform 1 more Hubble servicing mission
- Up to 7 crew, up to 56,000 lb of cargo

The Loss of Columbia

- Shaping NASA in the 21st century
- Technical cause: tank foam causing hole in lead edge heat shield
- Organizational causes: There were many
  - Lessons:
    - Success in past doesn't ensure success in future
    - Give technical staff an alternative route to voice concerns
    - Communicate! Communicate! Communicate!

Return to Flight Efforts

- STS-114 first RTF mission July 2005
- STS-121 tentative launch summer 2006
- Both missions testing safety improvements since Columbia
  - Minimizing ET foam loss
  - Orbiter thermal protection (TPS) repair
  - Gather data on orbiter TPS damage

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Recovering a Shuttle at Edwards, CA

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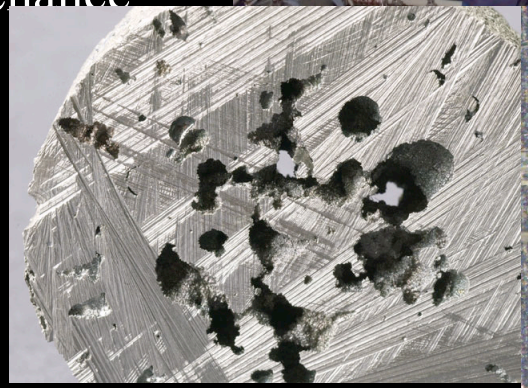
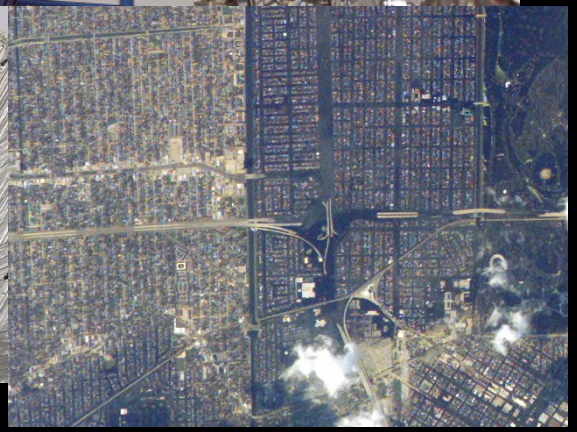
International Space Station

- First component launched in 1998
- Continuous occupancy since November, 2000
- It's BIG! (and still growing)
  - 240 ft x 146 ft x 90 ft
  - >400,000 lb
  - 15,000 cu ft habitable volume

Work Onboard

- US research focused on exploration vision
  - Effects on crew
  - Assembly of large structures
  - Operation and maintenance
  - Telemedicine
- Other science
  - Materials
  - Earth observation
  - Medical
  - Education





Exploration Systems

"We leave as we came, and God willing, as we shall return, with peace and hope for all mankind."

— Eugene Cernan, Commander of the last Apollo mission

The United States must lead the expansion of the space frontier to continue to maintain our world leadership role, and for the security of the nation.

Great nations do great and ambitious things. We must continue to be great.

The Exploration Roadmap

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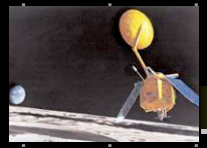
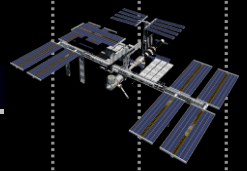


1st Human CEV Flight

Robotic Precursors

7th Human Lunar Landing

Lunar Outpost Buildup



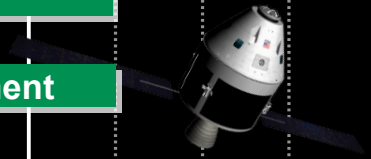
Mars Development

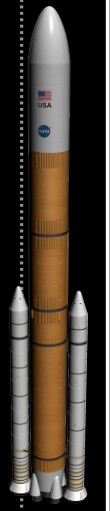
Commercial Crew/Cargo for ISS

Space Shuttle

CEV Development

Crew Launch Development



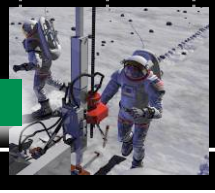


Lunar Lander Development

Lunar Heavy Launch Development

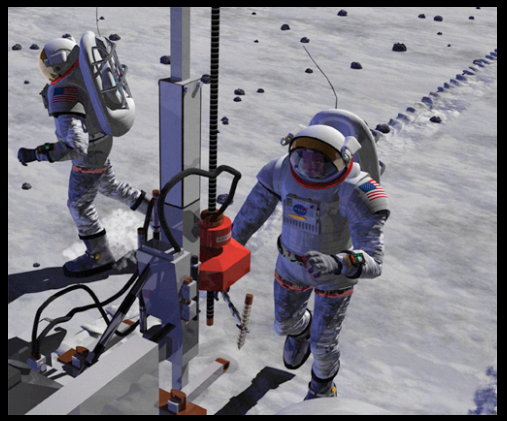
Earth Departure Stage Development

Surface Systems Development



The Moon - the 1st Step to Mars and Beyond….

- Gaining significant experience in operating away from Earth's environment
  - Space will no longer be a destination visited briefly and tentatively
  - "Living off the land"
  - Human support systems



- Developing technologies needed for opening the space frontier
  - Crew and cargo launch vehicles (125 metric ton class)
  - Earth ascent/entry system – Crew Exploration Vehicle
  - Mars ascent and descent propulsion systems (liquid oxygen / liquid methane)

- Conduct fundamental science
  - Astronomy, physics, astrobiology, historical geology, exobiology

Next Step in Fulfilling Our Destiny As Explorers

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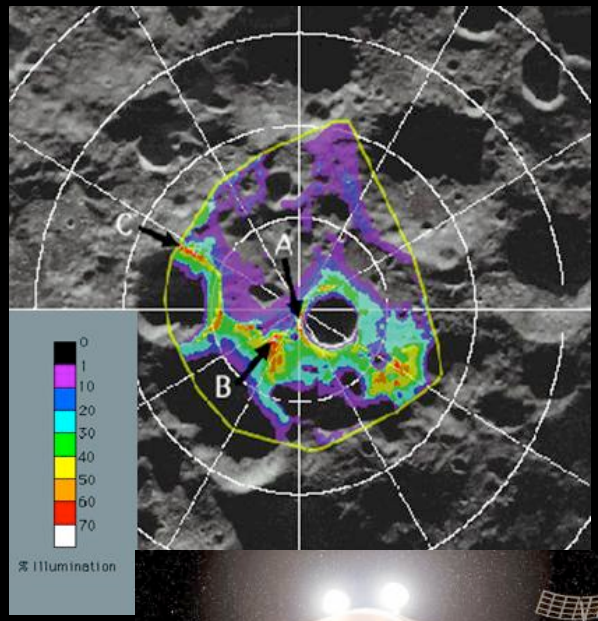
Possible South Pole Outpost

- The lunar South Pole is a likely candidate for outpost site
- Elevated quantities of hydrogen, possibly water ice (e.g., Shackelton Crater)
- Several areas with greater than 80% sunlight and less extreme temperatures
- Incremental deployment of outpost – one mission at a time
  - Power system
  - Communications/navigation
  - Rovers
  - Habitat and laboratory modules



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Crew Exploration Vehicle Concept

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Conclusion

- More information:
  - www.nasa.gov
- NASA Centers offer tours
  - Call ahead for times and reservations
- Thank You!